

SELF-TEST

A. Multiple Choice:

1. Dried beans swell on soaking in water. This is due to
 - a. deliquescence
 - b. supersaturation
 - c. osmosis
 - d. solubility
2. The solubility of a gas in water generally
 - a. decreases with increased pressure.
 - b. increases with increased pressure.
 - c. is independent of pressure.
 - d. increases with increased temperature.
 - e. is independent of temperature.
3. Consider a solution of 0.100 mol NaCl in 1.000 kg of water in a closed container at 75°C. When the solution is cooled, it contracts. How many of the following concentration variables change?

mass% of solute	mole fraction	molarity	molality
a. 0	b. 1	c. 2	d. 3
			e. 4
4. Concerning solubility, how many of the following statements are TRUE?
 - The solubility of butanol, C_4H_9OH , in water is greater than the solubility of butane, C_4H_{10} , in water.
 - Butanol, C_4H_9OH , is more soluble in hexane, C_6H_{14} , than is butane, C_4H_{10} .
 - The concentration of CO_2 in a bottle of soda decreases after the bottle is opened.
 - The oxygen available to fish in lakes is greater at the water's surface because the temperature there is higher.

a. 0	b. 1	c. 2	d. 3	e. 4
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5. Consider 0.100 *m* aqueous solutions of the following compounds.

sugar	KI	Na_2CO_3	$CaCl_2$	$CuSO_4$
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 - The freezing point of the Na_2CO_3 solution is below all the others.
 - Another solution in the list above has the same freezing point as the Na_2CO_3 solution.
 - The KI and $CuSO_4$ solutions have the same freezing point.
 - The freezing point of the sugar solution is below all the others.

The number of correct statements is

a. 0	b. 1	c. 2	d. 3	e. 4
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6. Which of the following correctly lists the compounds in order of *increasing* solubility in water?

<ol style="list-style-type: none">a. CCl_4, CH_2Cl_2, CH_3OHc. CH_2Cl_2, CH_3OH, CCl_4e. CH_3OH, CCl_4, CH_2Cl_2	<ol style="list-style-type: none">b. CCl_4, CH_3OH, CH_2Cl_2d. CH_2Cl_2, CCl_4, CH_3OH
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7. At 25°C, CO₂ dissolves in water with the release of heat. At the same temperature, KNO₃ dissolves in water with the absorption of heat. If the temperature is raised to 50°C and the pressure is kept constant, what happens to the solubilities of CO₂ and KNO₃?
- The solubility of CO₂ decreases while the solubility of KNO₃ decreases.
 - The solubility of CO₂ increases while the solubility of KNO₃ decreases.
 - The solubility of CO₂ decreases while the solubility of KNO₃ increases.
 - The solubility of CO₂ increases while the solubility of KNO₃ increases.
 - The solubility of CO₂ is unchanged while the solubility of KNO₃ increases.

B. Less than, Equal to, Greater than:

Consider the following beakers:

- Beaker A has 1.00 kg of a solvent Y and 0.100 mol of glucose (C₆H₁₂O₆).
- Beaker B has 1.00 kg of a solvent Y and 0.100 mol of CaCl₂.
- Beaker C has 1.00 kg of water and 0.100 mol of sucrose (C₁₂H₂₂O₁₁).

Answer the questions below, using **LT** (for *is less than*), **GT** (for *is greater than*), **EQ** (for *is equal to*), or **MI** (for *more information required*) in the blanks provided.

- _____ 1. The vapor pressure of pure water (1) the vapor pressure of the solution in Beaker C.
- _____ 2. The freezing point of the solution in Beaker A (2) the freezing point of the solution in Beaker B.
- _____ 3. The boiling point of the solution in Beaker A (3) the boiling point of the solution in Beaker C.
- _____ 4. The boiling point of the solution in Beaker B (4) the boiling point of the solution in Beaker C.
- _____ 5. The molality of the solution in Beaker A (5) the molality of the solution in Beaker C.
- _____ 6. The vapor pressure of the solution in Beaker A (6) the vapor pressure of the solution in Beaker C.

C. Fill in the blanks:

- _____ 1. Which is more soluble in water? $\text{CH}_3\text{CH}_2\text{OH}$ or $\text{H}_3\text{C}-\text{O}-\text{CH}_3$?
- _____ 2. An increase in pressure would increase the solubility in water of $\text{NH}_3(\text{g})$ or $\text{NaCl}(\text{s})$?
- _____ 3. Which of the 2 solids (AX or BY) would be more soluble if the temperature were increased?
- (1) $\text{AX}(\text{s}) \rightarrow \text{A}^+(\text{aq}) + \text{X}^-(\text{aq}) \quad \Delta H < 0$
- (2) $\text{BY}(\text{s}) \rightarrow \text{B}^+(\text{aq}) + \text{Y}^-(\text{aq}) \quad \Delta H > 0$
- _____ 4. Of the following 4 concentration units (M, m , % by mass, ppm), which cannot be obtained by making only mass measurements?
- _____ 5. If the pressure of CO_2 over water is tripled, then the solubility of CO_2 in water will be (5). (tripled, reduced by a third, increased 9-fold, reduced by a ninth)

D. True or False:

- _____ 1. The solubility of CO_2 in water is less than the solubility of CH_3OH in water at 25°C .
- _____ 2. The osmotic pressure of a solution at 100°C is equal to the osmotic pressure of the same solution at 0°C .
- _____ 3. The boiling point of a pure solvent is greater than the boiling point of its solutions.
- _____ 4. The freezing point depression of a 1 m aqueous solution of CH_3OH is less than that of a 1 m aqueous solution of NaCl .
- _____ 5. The molality of an aqueous NaCl solution that freezes at -1°C is equal to the molality of another solution of NaCl that boils at 101°C .
- _____ 6. The solubility of a gas with a Henry's Law constant of 0.0005 M/atm is less than that of a gas with a Henry's law constant of 0.002 M/atm at the same temperature.

E. Problems:

Consider a solution of aqueous $(\text{NH}_4)_2\text{CO}_3$ prepared by mixing 12.00 g of $(\text{NH}_4)_2\text{CO}_3$ with 125 g of water (density = 1.00 g/mL) to make 127 mL of solution.

1. Calculate the percent by mass of $(\text{NH}_4)_2\text{CO}_3$.

2. Calculate the mole fraction of $(\text{NH}_4)_2\text{CO}_3$.

3. Calculate the molarity of the solution.

4. Calculate the molality of the solution.

Consider an aqueous solution of potassium hydroxide.

5. How many liters of 3.50% KOH by mass with density 1.012 g/mL can be obtained by diluting 0.250 L of 30.0% KOH by mass (density = 1.288 g/mL)?

Consider an aqueous solution of nitric acid.

6. Calculate the molarity, mass percent, and mole fraction of nitric acid in an 8.92 *m* solution. The density of the solution is 1.22 g/mL.

Consider oxygen.

7. How many grams of oxygen can be dissolved in 1.00 L of water at 20°C if the oxygen pressure is 2.00 atm? The Henry's law constant for oxygen at 20°C is 1.38×10^{-3} M/atm.

Consider a solution prepared by adding 50.0 g of sucrose ($C_{12}H_{22}O_{11}$) to 250.0 g of water to make 275.0 mL of solution.

8. If the vapor pressure of pure water at 25°C is 23.79 mm Hg, calculate the vapor pressure of the water over the solution at 25°C .
9. Calculate the freezing point of the solution.
10. Calculate the boiling point of the solution.
11. Calculate the osmotic pressure of the solution at 25°C .

ANSWERS**Exercises:**

(E1) 1.10 M

(E2) 0.0445 mol

(E3) 33.9 g

(E4) 141 mL

(E5) 0.113 mol NH_4^+ ; 0.0375 mol PO_4^{3-}

(E6) 0.133 M

(E7) 2.7 g

(E8) 0.13 mg

(E9) 169 g/mol

(E10) Take 543 mL of the concentrated acid and add water to make 5.00 L of solution.

(E11) $X_{\text{solute}} = 0.0450$; 20.43%; 2.043×10^5 ppm

(E12) 293 mm Hg; 107 mm Hg

(E13) 44.1°C

(E14) 1.6×10^4 g/mol**Self-Test****A. Multiple Choice:**

1. c

2. b

3. b

4. c

5. c

6. a

7. c

B. Less than, Equal to, Greater than:

1. GT

2. GT

3. MI

4. MI

5. EQ

6. MI

C. Fill in the Blanks:1. $\text{CH}_3\text{CH}_2\text{OH}$ 2. NH_3

3. BY

4. M

5. tripled

D. True or False:

1. T

2. F

3. F

4. T

5. F

6. T

E. Problems:

1. 8.76%

2. 0.0177

3. 0.983 M

4. 0.999 *m*

5. 2.73 L

6. 6.97 M; 36.0%; 0.138

7. 0.0883 g

8. 23.54 mm Hg

9. -1.09°C

10. 100.30°C

11. 13.0 atm